Fisheries and Oceans Science | Pêches et Océans Sciences

CSAS
Canadian Science Advisory Secretariat

SCCS
Secrétariat Canadien de Consultation Scientifique

Proceedings Series 2001/12

Série des compte rendus 2001/12

Report of the PSARC Salmon Subcommittee Meeting, May 1-3, 2001

M. Stocker and A. Macdonald (Editors)
Pacific Scientific Advice Review Committee
Pacific Biological Station
Nanaimo, British Columbia V9T 5K6

May 2001

Canada

102-00682/

Report of the PSARC Salmon Subcommittee Meeting May 1-3, 2001

M. Stocker and A. Macdonald[1] (Editors)
Pacific Scientific Advice Review Committee (PSARC)
Pacific Biological Station
Nanaimo, British Columbia V9R 5K6

May 2001

[1] Fisheries and Oceans Canada
100 Annacis Parkway, Unit 3
Delta, British Columbia V3M 6A2

PACIFIC SCIENTIFIC ADVICE REVIEW COMMITTEE

PSARC ADVISORY DOCUMENT 2001-02
May 2001

SALMON

SUMMARY 2

INTRODUCTION 4

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION 5
S2001-08: Meziadin Lake biological escapement goal and options for increasing yield of sockeye salmon (*Oncorhynchus nerka*) 5
S2001-09: Assessment of coho stocks on the Queen Charlotte Islands/Haida Gwaii, 2001 8
S2001-10: Mortality rates of coho salmon caught by commercial salmon gillnets and the effectiveness of revival tanks and reduced soak time for decreasing coho mortality rates 11
S2001-11: Status in 2000 of coho stocks adjacent to the Strait of Georgia 16
S2001-12: Summary of stock assessment information for selected early returning chinook salmon populations of the Fraser River watershed 19
S2001-13: 2001 assessment of stock status for coho salmon from the Interior Fraser River 21
S2001-14: Review of the year 2000 return of Barkley Sound sockeye salmon and forecasts for 2001 25

APPENDIX 1: PSARC SALMON SUBCOMMITTEE MEETING AGENDA, MAY 1-3, 2001 29

APPENDIX 2: PSARC SALMON WORKING PAPERS FOR MAY 2001. 30

APPENDIX 3: PARTICIPANTS AT SALMON SUBCOMMITTEE MEETING, MAY 1-3, 2001 31

TABLES AND FIGURES 33

SUMMARY

The PSARC Salmon Subcommittee met May 1-3, 2001 at the Pacific Biological Station in Nanaimo. External participants from the Pacific Fisheries Resource Conservation Council, Sierra Club of B.C., B.C. Fish and Wildlife Federation, Area D Salmon Gillnet Association and the Fraser River Aboriginal Fisheries Resource Conservation Council attended the meeting.

Working Paper S2001-08: Meziadin Lake biological escapement goal and options for increasing yield of sockeye salmon (*Oncorhynchus nerka*)

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that the current goal of 160,000 for the Meziadin sockeye stock be maintained; the current goal is consistent with biological reference points of spawning escapement that provide maximum sustainable yield or maximum smolt production.

The Subcommittee recommended that determination of stock status and biological reference points is required for non-Meziadin sockeye stocks to evaluate the current management strategies for the Nass system.

The Subcommittee recommended that the potential enhancement strategies for Meziadin or other Nass sockeye stocks should only be considered after stock status and biological reference points for Nass sockeye has been determined.

Working Paper S2001-09: Assessment of coho stocks on the Queen Charlotte Islands/Haida Gwaii, 2001

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that a moderate increase in exploitation in 2001 (relative to 2000) for Areas 2E and 2W stock aggregates may be considered given the increase in brood year escapements in 1998, if survival is similar to forecasts for other northern B.C. stocks. However, these coho aggregates may not be able to support any increase above recent exploitation rates if marine survival and exploitation rates of the Deena indicator stock are representative of the aggregate.

The Subcommittee recommended development of additional high quality coho indicator stock assessment programs to better determine the status of Queen Charlotte Island coho stock aggregates.

The Subcommittee recommended that alternate sources of coho escapement or recreational catch data should be thoroughly documented, reviewed, and

reconciled.

Working Paper S2001-10: Mortality rates of coho salmon caught by commercial salmon gillnets and the effectiveness of revival tanks and reduced soak time for decreasing coho mortality rates

The Subcommittee accepted the paper subject to revisions.

To minimize mortality rates of coho caught in commercial gillnets, the Subcommittee recommended that short soak times are required.

The Subcommittee recommended that estimates of coho mortality rates should take into account the total soak time (including setting and retrieval times) since mortality is related to total soak time.

The Subcommittee recommended that additional research is required to improve revival box design.

Working Paper S2001-11: Status in 2000 of coho stocks adjacent to the Strait of Georgia

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that retention of fishing mortality rates at recent (1998-2000) low levels be continued.

Working Paper S2001-12: Summary of stock assessment information for selected early returning chinook salmon populations of the Fraser River watershed

The Subcommittee accepted the paper subject to revisions.

Following the Subcommittee recommendation made in March 2001, expansion of fisheries impacts on the four stocks identified in the paper (Birkenhead River, Coldwater River, Spius Creek and upper Chilcotin River) are highly inadvisable.

The Subcommittee recommended that a catch-monitoring program be implemented for early in-river fisheries on these and other Fraser spring chinook to resolve key data gaps for these stocks.

Working Paper S2001-13: 2001 assessment of stock status for coho salmon from the Interior Fraser River

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that current restrictions on fishing mortality for

interior Fraser coho in 2001 be continued.

Working Paper S2001-14: Review of the year 2000 return of Barkley Sound sockeye salmon and forecast for 2001

The Subcommittee accepted the paper subject to revisions.

The Subcommittee accepted the forecast return for Barkley Sound sockeye in 2001 based on the Survival Stanza Method (SStM). The forecast return of adults (age-4 and age-5) is 813,000 at the 50% probability level, and 738,000 at the 75% probability level.

The Subcommittee recommended that the key in-season indicators (sockeye abundance, age at maturity, run timing, etc.) be carefully monitored due to the large divergence of the forecasts from the alternate methods.

INTRODUCTION

The Subcommittee Chair opened the meeting welcoming the participants. During the introductory remarks the objectives of the meeting were reviewed, and the Subcommittee accepted the meeting agenda (Appendix 1).

The Subcommittee reviewed seven Working Papers. Working Paper titles and authors are listed in Appendix 2. A list of meeting participants, observers and reviewers is included as Appendix 3.

General Subcommittee Discussion and Concerns

The Subcommittee noted that provisional biological reference points were included in two papers at this meeting (S2001-11 and S2001-13). The Subcommittee concluded that it would be premature to use these reference points as a basis for evaluation of stock status and recommendations on fishery mortality rates because reference point definitions have not yet been finalised in the current draft of the Wild Salmon Policy (WSP). The Subcommittee expects that the evaluation of the status of stocks will be improved when a final WSP provides guidelines to establish and link conservation units and harvest rules.

WORKING PAPER SUMMARIES, REVIEWS AND DISCUSSION

S2001-08: Meziadin Lake biological escapement goal and options for increasing yield of sockeye salmon (*Oncorhynchus nerka*)

R.C. Bocking, M.R. Link, B. Baxter, B. Nass and L.Jantz **Accepted subject to revisions**

Summary

Meziadin Lake has historically produced sockeye salmon (*Oncorhynchus nerka*) returns ranging from 145,500 to 1.7 million, (average return of 511,000 adults) with an average escapement of 174,600. Two lake euphotic zone capability models [euphotic volume (EV) and photosynthetic rate (PR)], a Ricker stock-recruit function and fry recruitment analysis indicate that escapements between 150,000 and 185,000 are within the optimal range for the system. Above 200,000 spawners, the probability of returns being less than replacement increases, while at escapements below 150,000, and as low as 50,000, there have been good levels of recruitment. Nass sockeye are currently managed to a total aggregate escapement goal of 200,000. Historically, Meziadin sockeye have comprised between 45% and 95% of this aggregate. Accordingly, this management approach will result in net escapements to Meziadin of between 90,000 and 190,000 sockeye. These escapement levels are within the "safe" limits for ensuring adequate recruitment of Meziadin sockeye. Without improved information on the productivity of weaker Nass sockeye stocks, there can be little justification for changing the overall Nass escapement goal of 200,000. There is some evidence that the yield of sockeye from Meziadin Lake could be increased by increasing fry size and hence, survivals from smolt to adult through a lake fertilization program. However, we recommend that experimental manipulations of lake productivity not be considered further until assessment and management procedures to safe-guard the weaker stocks are developed or the capability to harvest Meziadin sockeye surplus to escapement at terminal locations is developed.

Reviewers' Comments

Reviewer #1

Reviewer #1 felt that the purpose of the working paper is clearly stated. The descriptions of methods and data sources described apply specifically to brood years from 1993 to 1998. However, for the first three years of the data sets presented in the paper (brood years 1990-1992 and lake years 1991-1993) lake surveys were conducted and samples processed by the Salmon Index Methods group at the Pacific Biological Station (PBS) working in collaboration with First Nations and consultanting company participants. Consequently, this reviewer

felt that the methods text needs to be expanded further to address potential changes in sampling and/or sample analysis protocols.

This reviewer felt the rationale and assumptions behind the estimates of fall fry to smolt survival and a constant smolt to adult survival need to be treated in more detail to verify their applicability to Meziadin sockeye. The optimum escapement values identified in the paper will be forced in part by these assumptions so it is important that they be defensible before accepting the resultant values. The conclusion under both lake capacity models presented is that "optimum" escapement is greater than 174,000 adults.

This reviewer was not convinced with the authors suggestion that given current conditions in the lake, that available spawning habitat is not limiting sockeye production beyond the limitations imposed by lake rearing capacity. Reviewer #1 agreed with arguments in the working paper that "increasing available spawning habitat would not result in higher yields (because of the low egg-to-fry survival) but is not convinced that this is predicated on any clear demonstration of rearing limitations in the lake. Indeed, given the clear demonstration of an average low egg-to-fry survival across virtually all spawner abundances one could argue that enhancement to increase egg-to-fry recruitment could still be used to increase yield available to the fishery by reducing the requirement for large escapements producing low average fry recruitment.

Reviewer #2

Reviewer #2 felt that the authors provided a good assemblage of the juvenile, adult, and limnological data available for Meziadin Lake. However, an overarching general concern of this reviewer was that the analysis of the data was weak, particularly because uncertainty in the data was not considered, and results were not presented in such a way as to communicate this uncertainty and to support the conclusions that lake carrying capacity is limited and the "biological" escapement target is 160,000 sockeye.

Reviewer #2 felt that the data seemed to be adequate to support the conclusions but methods need to be expanded upon. In particular, this reviewer was left unconvinced that lake carrying capacity is limiting production and not spawning habitat. However, from the data provided in the report the reviewer calculated an estimate of biomass and plotted fry numbers vs biomass which strongly suggests that carrying capacity of the lake has been reached or exceeded on a few occasions. This reviewer felt that the report would benefit from this type of additional analysis. The S/R analysis provided suggests a Maximum Sustainable Yield (MSY) of 160K, it was unclear from reading the report if the juvenile analysis supports this conclusion as well.

This reviewer felt the data available in the report were adequate to support most of the conclusions so recommended that the authors undertake revisions that

would incorporate more detail in the methods section and provide additional analysis of the data. This reviewer felt all the data components are present but they were not tied together in a compelling way to support the conclusions and justify recommendations.

Subcommittee Discussion

This paper provides a valuable update of juvenile sockeye and limnological data for Meziadin Lake. However, the analysis and discussion of the data is flawed by several weaknesses. The addition of more details on data analysis, differences in survey or analytical methods used during various survey intervals and explicit estimates of uncertainty in various observation sets warrants attention as pointed out by both reviewers of the paper. As currently presented, the arguments that lake carrying capacity limits production of Meziadin sockeye as opposed to spawning ground capacity is not convincing. A clear case can be made from the observations and analysis that the biologically based escapement objective of 160,000 sockeye established previously does not warrant revision at this time.

In general, the Subcommittee concluded that there was a strong basis in the data presented to identify a biologically based escapement objective for Meziadin sockeye as evidenced by the convergence of escapement estimates provided from both habitat productive capacity calculations and from stock recruit analysis. One Subcommittee member noted that this convergence of estimates might be even closer if a bias correction procedure as per Walters et al. was introduced into the stock recruit analysis.

Following extensive discussion on the contents of the paper, Subcommittee members felt that the contents of the paper should be revised to: (1) identify the evidence for a biologically based escapement objective for Meziadin sockeye alone; (2) deal with identifying the various options that results here suggest have potential as a means to increase the long term production of Meziadin sockeye and; (3) identify the general requirement to provide assessments of the productive capacity, stock status and manageability of non-Meziadin stocks as a pre-requisite for future decisions to implement options for increasing Meziadin sockeye production.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that the current goal of 160,000 for the Meziadin sockeye stock be maintained; the current goal is consistent with biological reference points of spawning escapement that provide maximum sustainable yield or maximum smolt production.

The Subcommittee recommended that determination of stock status and

biological reference points is required for non-Meziadin sockeye stocks to evaluate the current management strategies for the Nass system.

The Subcommittee recommended that the potential enhancement strategies for Meziadin or other Nass sockeye stocks should only be considered after stock status and biological reference points for Nass sockeye has been determined.

S2001-09: Assessment of coho stocks on the Queen Charlotte Islands/Haida Gwaii, 2001

B. Spilsted, P. Fairweather, and R.C. Bocking **Accepted subject to revisions**

Summary

This paper summarizes stock assessment information for coho salmon (*Oncorhynchus kisutch*) stocks of the Queen Charlotte Islands/Haida Gwaii. This area encompasses Fisheries and Oceans Canada (DFO) Statistical Areas 1, 2 West and 2 East, with a coho stock aggregate of 227 separate spawning populations documented in Departmental escapement records since 1950.

Historic escapement information is reviewed in terms of assessing techniques that provide annual indices of abundance for these streams. Recent area-under-the-curve escapement data produced by the Haida Fisheries Program is compared with DFO annual estimates. Information summarizing adult and smolt timing data, biological characteristics, stock composition in certain marine fisheries, commercial exploitation rate estimates and recent juvenile density work is presented. Coded wire tag (CWT) information is utilized to provide an index of relative abundance and ocean run timing of Queen Charlotte Island/Haida Gwaii coho through northern Canadian and Alaskan commercial and recreational fisheries. CWT recoveries are presented showing when and where this stock is harvested by major gear and area aggregates.

Recent work by the Haida Fisheries Program has provided coho carrying capacity estimates for many streams. These very preliminary data are summarized, and these values are compared to abundance index data and Fisheries Management escapement target values.

Information is presented giving an overview of the coho assessment plan for this area, resulting from collaboration between DFO Stock Assessment, Fisheries Management, Haida Fisheries Program and local community representatives.

Reviewers' Comments

Reviewer #1

The reviewer believed that this paper was the first thorough review of coho

populations in this region. The reviewer commended the authors for compiling the information, and going through a careful analysis with respect to the quality of the data and the types of inference that can be drawn from them. The reviewer commented that although the paper competently describes the historical perspective of these stocks, data do not appear to be available to indicate current stock status or where to go in the next few years.

The reviewer concluded that it appears that regardless of how the data are arranged, there has been a decline in the abundance of 2W and 2E aggregates since the 1960s, and little trend in Area 1 abundance. The reviewer pointed out that an examination of exploitation rate histories and survival rate information may help identify the causes of the declines.

The reviewer commented on three topics: marine survival, juvenile data, and stream production capacity. On the issue of marine survival, the reviewer felt that estimates from the Deena River are relatively low (2.3 and 1.4%) compared to those from the North coast, and are at the lower limits of what will result in sustainable populations. The low survival rates suggests either a bias in the methods or that there should be a concern about the short term productivity. On the issue of juvenile data, the reviewer felt that a review is required to determine what these data are useful for, how the data should be processed, and why the data are being collected. Finally, on the issue of stream production capacity, the reviewer felt that the estimation method should be reviewed, either in the paper or in a separate assessment paper.

Reviewer #2

This reviewer felt that the paper contains a rich collection of useful fisheries information, but most of it in independent pieces. The final step of combining those pieces and translating the knowledge into useful advice for management has not been completed. The reviewer felt that the authors make a number of recommendations that are unsubstantiated by data or logical argument. Further, this reviewer does not believe that the results of data analysis adequately support some of the statements made in this document. New escapement indices are correlated to those in Holtby (Canadian Stock Assessment Research Document 2000/128) - it might be useful to gauge the extent of overlap between the new and 'Holtby' data. Based on its preliminary nature, Reviewer #2 felt that the section addressing stream production capacity should be removed. With some revisions, this manuscript would be a very useful starting point in presenting available information on QCI coho.

Subcommittee Discussion

Subcommittee discussion focused on a supplementary summary of stock status commentaries and assessment recommendations provided to the Subcommittee by the authors during their presentation of the paper. The Subcommittee

concluded that coho abundance of stock aggregates in Areas 2E and 2W, based on escapement estimates, have declined since the 1950s (Figures 1 and 2) and their status appears to be generally depressed. Area 1 stock aggregate escapements have not followed the same trends as 2E and 2W. The Subcommittee noted the increase in brood year (1998) escapements from 1997 for the Areas 2E and 2W aggregates. The Subcommittee concluded that a moderate increase in exploitation in 2001 (relative to 2000) for Areas 2E and 2W stock aggregates may be considered given the increase in brood year escapements in 1998, if survival is similar to forecasts for other northern B.C. stocks.

The Subcommittee observed that data sufficient to assess marine survival and exploitation rates was only available for the Deena River coho stock, the only key stream for wild populations from the Queen Charlotte Islands. The Subcommittee noted the authors' concern about uncertainties and estimation difficulties in the smolt and fry estimations, although effects of these potential biases were not examined in detail in the paper. The survival and exploitation rate estimates may not be representative of larger coho stock aggregates in the area (i.e. both marine survival and exploitation rate estimates are low), suggesting that the stock is relatively unproductive). Consequently, the Subcommittee suggested consideration be given to the development of additional high quality coho indicator stocks to assess the status of Queen Charlotte Island coho stock aggregates.

The Subcommittee noted that development of an enumeration plan and indicator stocks with multiyear support and collaboration by those parties involved would be required to develop a program that would improve the level of resolution that limited current assessment data provide.

The Subcommittee noted that the working paper references both DFO and the Haida Fisheries Program as alternate sources for escapement and recreational fisheries catch estimates for coho in some years and areas. Although the working paper raised the issue of which estimates might be assumed to be superior, the Subcommittee concluded that the working paper did not provide a sound basis for final resolution of this issue.

The Subcommittee noted that the working paper referred to a productive capacity model for Queen Charlotte Island coho. The authors noted that the model and results were very preliminary and planned to submit a working paper on this topic for PSARC review in the fall of 2001.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that a moderate increase in exploitation in

2001 (relative to 2000) for Areas 2E and 2W stock aggregates may be considered given the increase in brood year escapements in 1998, if survival is similar to forecasts for other northern B.C. stocks. However, these coho aggregates may not be able to support any increase above recent exploitation rates if marine survival and exploitation rates of the Deena indicator stock are representative of the aggregate.

The Subcommittee recommended development of additional high quality coho indicator stock assessment programs to better determine the status of Queen Charlotte Island coho stock aggregates.

The Subcommittee recommended that alternate sources of coho escapement or recreational catch data should be thoroughly documented, reviewed, and reconciled.

S2001-10: Mortality rates of coho salmon caught by commercial salmon gillnets and the effectiveness of revival tanks and reduced soak time for decreasing coho mortality rates

B. Hargreaves and C. Tovey **Accepted subject to revisions**

Summary

In 1998, a number of events changed the conservation, management and harvest opportunities for salmon in the Pacific Region of Canada. Due to growing concerns about the declining abundance of key coho salmon (*Oncorhynchus kisutch*) populations in both northern and southern B.C. an intensive review and public consultation process was initiated by Fisheries and Oceans Canada. On May 12, 1998 the Department's Coho Response Team issued its report titled "Selective Fisheries Approach For Management of B.C. Salmon Fisheries in 1998". This report provided a Selective Fisheries Management Framework and new options for management of salmon fisheries that included near-zero mortality for critical coho populations and requirements for fishing gear and methods to become more selective. Selective fishing was defined as the ability to avoid, or release alive and unharmed, non-target stocks or species of concern.

Since 1998 more than 100 selective fisheries experiments have been conducted in B.C. by the First Nations, recreational and commercial salmon fishing sectors with direct support from the Department's Pacific Fisheries Adjustment and Restructuring program (PFAR). The main purpose of these selective fishing experiments was to develop new fishing gear and methods aimed at reducing the coho catches, and reduce the mortality rates of any coho that are captured incidentally while harvesting other target species or stocks of salmon.

The purpose of this PSARC Working Paper was to summarize and evaluate the results obtained from selected selective fishing experiments conducted since

1998. The main focus was on the mortality rates of coho salmon caught with commercial salmon gillnets. The three components of coho mortality that were examined included: 1) the immediate mortality that occurred when coho were captured, 2) the additional mortality that occurred during subsequent holding of coho in revival tanks aboard the fishing vessels and 3) the short-term (up to 48 hour) delayed mortality that occurred after the coho were released from the fishing vessels.

The other objective of this paper was to evaluate the effect on coho mortality of reduced net soak time, and the use of on-board revival tanks for resusitating coho caught in commercial salmon gillnets. Short soak times and revival tanks were introduced by the Department in 1998 as mandatory requirements in commercial salmon gillnet fisheries.

The results presented in this working paper indicate that the incidental mortality rates of coho caught in commercial gillnets are highly variable. The immediate (catch) mortality rates ranged from 47.4% to 0.0% among the 11 different studies that were examined in detail. The additional mortality that occurred during holding of coho in onboard revival tanks was typically in the range of 5-10%, although 30% of the coho held in revival tanks died in one study. The additional short-term mortality of coho that were held in net pens for up to 48 hours after release from the fishing vessels ranged from 2.3% to 27.3%.

In the two studies that had the most comprehensive data, much of the variation in coho mortality rate at the time of capture was explained by a linear relationship between coho mortality rate and gillnet soak time (the duration that the gillnet remained in the water for each fishing operation). In the Alberni Inlet experiment in 1998, which involved only 7 commercial gillnet vessels, more than 95% of the observed variation in coho catch mortality rate was explained by the variation in soak time. In the Skeena River demonstration gillnet fishery in 2000, which involved about 40 commercial gillnet vessels, about 70% of the variation in coho catch mortality rates was explained by the variation in soak time.

It was concluded that coho catch mortality rates increase rapidly with increasing soak time, and that short soak times of less than 60 minutes (defined as first cork in to last cork out) are likely required to achieve coho mortality rates that are substantially lower than the rate (60%) that the DFO has assumed for most commercial gillnet fisheries since 1998.

It was concluded that revival tanks are generally beneficial for improving the condition of many coho prior to release. Appropriate use of revival tanks likely also improves the post-release survival rates of coho that are released from commercial gillnet vessels.

The capability of revival tanks to revive coho caught in commercial gillnets decreases with increasing soak time. The data currently available are insufficient

to confirm which of the current two main alternative designs [the DFO "blue box", or the newer "Jake Fraser" (JF) revival tank] is more effective for reviving coho, particularly in either demonstration scale or regular full-fleet gillnet fisheries. Additional direct experiments (e.g. side-by-side comparisons with adequate experimental controls) are still required to clearly confirm if the new JF revival tank design is superior. The current data do suggest that the JF revival tank design likely provides little advantage over the standard DFO "Blue Box" revival tank when soak times are very short (e.g. <30 minutes; first cork in to last cork out). However, the new JF design may significantly reduce coho mortality rates for moderately longer soak times (e.g. 30-100 minute soak times), compared to the standard DFO revival tank. Neither the new JF revival tank or standard DFO revival tank designs are likely to be effective for reviving coho caught in sets with longer soak times (e.g., >100 minutes).

The authors emphasized that the analyses and conclusions in this working paper apply only to the short-term mortality of coho and do not address the additional important question of what effect capture and release from commercial gillnets may ultimately have on coho mortality beyond 48 hours after release from fishing vessels, or on the ultimate spawning success of these coho salmon. It was also noted that the actual impact of commercial gillnet fisheries on salmon stocks of concern depends on both the mortality rates and the encounter rates. This working paper considers factors that affect the mortality rate of incidentally caught coho, but does not evaluate or consider the factors that affect coho encounter rates.

Reviewers' Comments

Reviewer # 1

The working paper re-analyses a number of foregoing B.C. selective fishing projects addressing mitigation of coho bycatch from gillnet gear. It is a useful work, providing a valuable and needed perspective on both the merit of shorter gillnet soak times and the continuing evolution of revival tank design and use on gillnetters. The recommendations for fisheries management are reasonable and defensible, given the quantity and the nature of the available data.

The paper's conclusions about sustaining the use of revival tanks and keeping gillnet soak times short when bycatch encounters are expected are well supported by the data. The authors recognize the problem of the lack of a clear standard definition of soak time, but other potentially powerful factors such as sea temperature, bycatch exposure to air and delayed mortality are not well acknowledged.

The paper treats small-scale experiments and large-scale demonstration fisheries similarly without consideration of the potential differences between them. This fact will likely not affect strongly the conclusions about the benefit of

shorter gillnet soak times, but may have considerable influence on the question of the value of revival tanks in general, and also their designs and use. Therefore, the recommendations about continued study of revival tank topics are particularly important, in light of the apparent capacity of the JF tank design to revive coho initially deemed dead.

Reviewer #2

This paper summarizes and evaluates results for selective gillnet fishing experiments conducted since 1998, with focus on the effectiveness of revival boxes and shorter soak times for reducing mortality rates of by-catch coho. Of the 11 available studies considered for this analysis (summarized in Appendix 1 of the working paper), the authors found only three that provided sufficient information for evaluating:

1) the immediate mortality that occurred when coho were initially captured,
2) the additional short-term mortality that occurred during subsequent holding of coho in revival boxes aboard the fishing vessels, and
3) the delayed mortality that occurred after the coho were released from the fishing vessel.

The issue of reducing by-catch mortality in gillnet fisheries is very important, and this paper is the first to objectively quantify results from the diverse range of studies that have been conducted to date.

In general, this reviewer found the paper to be clearly written and (relatively) well organized. While the range of coho mortality rates is quite wide for the studies considered, the authors' review indicates some potential for reducing coho mortalities in gillnet fisheries through the continued use of revival boxes, new revival box designs, and moving towards shorter set (soak) times. However, as the authors note, there is still considerable uncertainty regarding just how effective these measures will be in actual commercial fishing situations. Intuitively, the newer revival box designs and shorter set times should lower by-catch mortality rates in gillnet fisheries. Unfortunately, the data are currently insufficient to statistically evaluate the former, and effective implementation and compliance may be an issue with the latter.

Subcommittee Discussion

The Subcommittee's discussion focused on the two main aspects of the working paper: 1) the effect of variable soak time on coho mortality rates,and 2) the effect of revival tanks on the recovery of coho after capture by commercial gillnets.

The authors clearly demonstrated that coho mortality rates are positively related to soak time (Figure 3).

Soak time measurements that are used to estimate mortality rates of coho must include the total amount of time a gillnet is deployed, including the time required

to set and retrieve the net. All four times that are required to assess the various measures of soak time (first cork into the water, last cork in, first cork out, last cork out) should be recorded and are required in order to accurately estimate coho mortality rates.

The Subcommittee noted that this working paper discusses only the mortality rates of coho caught in commercial gillnets, and does not address the question of coho encounter rates. Both encounter rates and mortality rates are required to allow estimation of total mortality of coho that results from a fishery. The Subcommittee noted that evaluation of the factors that affect coho encounter rates is also important but acknowledged this was not the purpose of this working paper and will require extensive additional work.

The large variation in results among the various studies examined in this working paper may be the result of many factors, including inadequate experimental design in some cases. Some of the observed variation likely also resulted from the differences between results obtained from tightly controlled scientific experiments (e.g. using one fishing vessel) and less tightly controlled experiments that were part of commercial fisheries (using 10-40 vessels).

The Subcommittee agreed that recovery tanks benefited coho classified as lethargic or not moving or ventilating (Figure 4). Allowing stressed fish to recover before releasing them into the ocean likely increases survival rates (e.g. by reducing opportunities for immediate predation). However, there was no evidence that recovery tanks benefited coho classified as vigorous. The Subcommittee noted that further experiments are required to assess which design of recovery tank is more effective.

The Subcommittee could not support general application of the specific mortality rates reported in this working paper because of unknown effects of uncontrolled factors (e.g. variable oceanographic conditions, unmeasured physiological stress factors, variable gear types) on mortality rates.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions.

To minimize mortality rates of coho caught in commercial gillnets, the Subcommittee recommended that short soak times are required.

The Subcommittee recommended that estimates of coho mortality rates should take into account the total soak time (including setting and retrieval times) because mortality is related to total soak time.

The Subcommittee recommended that additional research is required to improve revival box design.

S2001-11: Status in 2000 of coho stocks adjacent to the Strait of Georgia

K. Simpson, D. Dobson, R. Semple, S. Lehmann, S. Baillie, and I. Matthews **Accepted subject to revisions**

Summary

Escapements in 2000 remained poor relative to 10 year averages in all areas of the Georgia Basin except in the lower Fraser system. In terms of the provisional limit reference point of 3 females/km, virtually all enumerated stocks in the Basin were probably above the limit. Escapements were the result of poor escapements in 1997 and poor marine survival. Most indicator stocks did not improve on their 1997 escapements. Extremely low marine survival is the driving short-term cause of poor abundances. Survival of populations on southeast Vancouver Island is a particular concern. However, the decline has stopped, with survivals of virtually all indicator stocks in the Basin improving at least slightly. Largely as a result of Selective Mark Fisheries, exploitation of hatchery stocks about doubled to 24% in 2000. Exploitations of wild coho probably also increased with the increased fishing effort but their level is uncertain and will vary with ocean distribution.

Smolt runs were probably above average in 2000 on Vancouver Island but remained poor on the Sunshine Coast (Areas 15 and 16). The number of smolts was not exceptional at Salmon River in the lower Fraser Valley but fry densities and sizes in 1999 suggest smolt abundances elsewhere in the area may have shown a greater improvement. Smolt runs may have been comparable to 1997, the previous smolt run in this brood line. In a previous PSARC Working Paper, marine survivals and abundances were forecast to remain about the same as in 2000. Forecasts were based on time series projections but the probability of increased ocean recruitment means the forecast abundance (which we are not revising) is more likely to be an under-estimate than an over-estimate. Assuming continued low exploitation of wild stocks, most monitored populations will probably exceed the provisional limit reference point of three females per kilometre of stream as they have in 1998 and 1999. Considering the current low productivity of Georgia Basin coho, the authors recommend that fishing mortality remain similar to existing minimal levels in order to ensure that there is a sufficient proportion of escapements that exceed the provisional Limit Reference Point (LRP).

The abundance of smolts this spring (2001) will probably be below the 10 year average. The authors expect smolt numbers to remain especially poor on the Sunshine Coast. Throughout all monitored areas of the Basin, fry densities were below average in 2000. This probably resulted from low escapements in 1999. Their sizes were small, despite lower densities, suggesting over-winter survival may have suffered. However, this winter has been unusually dry and it is not clear what the effect on survival has been.

Two areas of particular concern with respect to their status are the Sunshine Coast (Area 15 and 16) and southeast Vancouver Island (Areas 18 and 19).

The authors recommend in the paper that Regional rules or guidelines for the collection and analysis of escapement data are required, especially if stock assessment frameworks use Limit Reference Points of spawner abundance. The likelihood of obtaining reasonably accurate absolute, as opposed to trend, measures of escapement needs to be carefully considered. They also recommended that the lower Fraser area requires another full indicator facility or, failing that, more smolt enumerations coupled with fry and adult estimates.

Reviewers' Comments

Reviewer #1

The primary contribution of the paper is the results of monitoring escapement, fry, smolt, exploitation and survival in 2000. Reviewer #1 felt that the authors have done a good job in assembling and documenting the large array of assessment data and have adequately described the deficiencies in the data. Because a provisional LRP of 3 females/fm is discussed in this paper, the authors should include a summary of the derivation and implication of the LRP to coho conservation. Although the reviewer agrees that quantifying the errors in escapement estimates is difficult, simulations to assess the sensitivity of estimates to assumptions about stream life and observer efficiency may be tractable at least in terms of assessing the potential range of escapement error relative to the LRP. The conclusion that "virtually all" surveyed systems were above the provisional LRP in 2000 may or may not be reasonable. Depending on the underlying uncertainty in the escapement estimates that is admittedly and potentially large, the proportion with < 3 females/km could be larger than the point estimates presented in the paper. The reviewer agreed that when operational LRPs are adopted, the need for more precise escapement estimates is problematic. The reviewer agreed that if absolute escapement estimates are required to assess stocks relative to an LRP, then guidelines for data collection and analysis of escapement data will be required. If stream life is a limiting parameter in the estimate of escapement then the reviewer would support the conclusion that more stream life data is needed.

The authors note the presence of seals in the vicinity of Black Creek and briefly discuss the potential for seal predation on coho survival. This hypothesis has been examined elsewhere in the region and represents an avenue for exploring potential explanations for declines in coho survival. This reviewer strongly supports the recommendation for continued low fishing mortality rates. The level should eventually be linked to ensuring the risk of exceeding an LRP is tolerable. The consequence of exploitation on the risk of not meeting the LRP by a "sufficient" number of populations is a necessary avenue of assessment in view of recent data and changes to the fishery (i.e. implication of increased effort from

selective fisheries). This opens up a range of issues relative to data uncertainty. What are the implications in risk assessment of low reliability in estimates of exploitation, and possibly underestimates of exploitation, given low sampling of coded-wire tags (CWTs) and implications of potential errors in release mortality estimates? The reviewer also supported the need to consider ways of dealing with the apparent dichotomy between Lower Fraser River population trends, such as Pitt and Salmon River trends in escapement.

Reviewer #2

This reviewer agreed with the authors' conclusion that coho stocks in the Georgia Basin continue to experience low levels of abundance primarily due to poor parental adult escapement in 1997 and poor marine survival thus warranting that fishing mortality be maintained at existing low levels. The reviewer also agreed that standardized guidelines are needed for the collection of fry survey and escapement data and that another mainland wild indicator is needed. The reviewer concluded that the paper should be accepted after the following comments are addressed. These include measures of uncertainty that are not provided for data such as area-under-the-curve (AUC) estimates and error bounds not provided for regressions. More work needs to be done comparing the relationship of fry densities if they are to be an accurate means of estimating escapement in larger numbers of coho streams particularly because of contradictions with some of the correlations presented in the paper.

Subcommittee Discussion

The Subcommittee noted that low exploitation rates have allowed escapements to stabilize but total abundance is still very low compared to historical levels. Escapements in 2000 were poor, the result of poor brood year escapement in 1997 and poor marine survival. The Subcommittee noted the levels of escapement relative to a provisional limit reference point but cautioned the use of such comparisons until the issues raised in the 'General Discussion' section of the Subcommittee report are resolved.

The Subcommittee noted that based on fry densities and size, smolt runs for the 1998 brood were probably above average in most areas of the Georgia Basin except the Sunshine Coast and probably comparable to those in 1997, the previous smolt run in this brood line. Although marine survivals are expected to remain poor, this increased ocean recruitment may mean that forecast abundance in 2001 may be an underestimate. For the 1999 brood, fry densities and size were below average in all areas monitored, indicating that over-winter survival may have been below average as well. The Subcommittee also noted the authors particular concern on the status of the Sunshine Coast (Areas 15&16) and South East Vancouver Island (Areas 18 & 19).

The Subcommittee noted that there was no additional information provided in the

working paper that would change current status of coho stocks adjacent to the Strait of Georgia. Based on the continued low marine survival and low total abundance, the Subcommittee agreed with the authors and the two reviewers that fishing mortality should be retained at recent (1998-2000) levels.

The Subcommittee noted a reviewer's recommendation as well as a previous Subcommittee suggestion made in May 2000 that the uncertainty of area-under-the-curve estimates needs to be provided to assess escapement estimates.

The Subcommittee also noted that based on a previous Subcommittee recommendation from May 2000, one (on the Sunshine Coast) of two additional wild indicator stocks (the second was in the Lower Fraser) was established.

Subcommittee Recommendation

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that retention of fishing mortality rates at recent (1998-2000) low levels be continued.

S2001-12: Summary of stock assessment information for selected early returning chinook salmon populations of the Fraser River watershed

R.E. Bailey, J.R. Irvine, J.R. Candy, C.K. Lemke, M. Sullivan, and M. Wetklo **Accepted subject to revisions.**

Summary

Escapement histories and recent catch data were summarised and reviewed for four early-timed Fraser River spring-run chinook populations: Birkenhead River, Coldwater River, Spius Creek, and upper Chilcotin River. A thorough assessment of the status of these populations is difficult since the quality of spawner escapement data is generally poor for Coldwater River, Spius Creek, and upper Chilcotin River fish although there was a short but consistent time series of surveys on the Birkenhead River. Analyses of the data do not indicate any temporal pattern although escapements of each population have been extremely low (<250 spawners) on several occasions over the past decade. Based on DNA and CWT analyses, it is clear that most harvest occurs in the lower Fraser First Nations fishery, especially for Spius and Coldwater River populations, although Birkenhead and Chilcotin populations are caught on occasion in marine fisheries. The apparent harvest rate for the four populations (pooled) was 33% by the end of April and in some years may reach much greater levels.

Reviewer's Comments

Reviewer #1

The working paper provides a summary of the recent-year assessment information for four populations of the early-timed Fraser River spring-run chinook aggregate. The authors provide life history information of the four populations, which is important as it assists in the interpretation of some data sets. The authors note that the spring-run aggregate declined in abundance prior to 1980. The assessment information provided would then be for a period after the run declined.

The authors conclude that, for recent years, the returning spawners are low, the annual escapements appear to be without a trend and that the escapements are probably inadequate to fully utilize the spawning capacity of the systems. In-river catches, although reduced compared to historic catches, are trending upwards. The marine and in-river catch information indicates the majority of exploitation is in-river and with an apparent in-river harvest rate which may not be sustainable during periods of low ocean survival.

The working paper is a useful first summary of information and has an equal importance of identifying additional data requirements for future assessments of this aggregate. The authors note some ten areas of limitations to the available data sets for the four populations. These limitations diminish the value of an already short time series of assessment data. As well, the spring run aggregate includes about 25 populations that spawn throughout the watershed. Information on only four populations is available (three in the lower-area, one in the mid-area but none in the upper-area where the majority of populations spawn). Assessment activities need to be implemented to address the limitations of the existing data and the inclusion of additional early returning stocks in the upper Fraser drainage.

Subcommittee Discussion

The Subcommittee discussed the possibility that in-river exploitation rates could be "much" greater than those estimated or simply greater. The lead author agreed that the exploitation rates were likely greater but that the underestimate is not likely to warrant the characterization given.

The Subcommittee dealt with the lack of clarity in the paper concerning the distinctions between the earliest of the spring run (the four populations of concern) and the rest of the spring chinook populations. The authors responded that there remain uncertainties in the run-timing in the ocean, into the river, and within systems like the Chilcotin but will make clearer the basis for decisions made about cut-off times for river-entry. The authors also suggested that they could make impacts of in-river fisheries on the earliest-run (the four populations)

clearer or more explicit and truncate the period of interest at the end of April.

The Subcommittee questioned the authors' assertion that the four populations may not be able to sustain current levels of harvest during periods of low ocean survival. The Subcommittee concluded that there was insufficient information available to determine this point with certainty.

The Subcommittee questioned the apparent absence of CW-tagged chinook from these stocks from the Mark-Recovery Program. With the exception of Birkenhead the current hypothesis is that these stocks go offshore and are not vulnerable to traditional ocean fisheries. The only fishery that might impact significantly on these stocks is the lower river aboriginal fishery. This led to discussion of the lack of adequate catch monitoring programs in the Fraser that are impacting these stocks.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions.

Following the Subcommittee recommendation made in March, 2001, expansion of fisheries impacts on the four stocks identified in the paper (Birkenhead River, Coldwater River, Spius Creek and upper Chilcotin River) are highly inadvisable.

The Subcommittee recommended that a catch-monitoring program be implemented for early in-river fisheries on these and other Fraser spring chinook to resolve key data gaps for these stocks.

S2001-13: 2001 assessment of stock status for coho salmon from the Interior Fraser River

J.R. Irvine, C.K. Parken, D.G. Chen, J. Candy, T. Ming, J. Supernault, W. Shaw, and R.E. Bailey **Accepted subject to revisions**

Summary

The extreme fishery management measures undertaken in B.C. since 1998 to conserve coho appear to have stopped the declining trend of interior Fraser coho populations. The authors evaluated the impacts of continued restrictions in salmon harvest on the status of coho salmon of the interior Fraser River, including the Thompson drainage in 2000. Fishery exploitations in 2000 were the lowest on record, ~3.4% in total, of which approximately half was in British Columbia. Fishery exploitations the last two years were low enough that spawner numbers generally exceeded brood escapements. Productivity measured in recruits per spawner has improved and populations are now above replacement levels.

A mark-recapture program that used fishwheels in the Fraser Canyon (Figure 5)

as marking platforms provided an independent estimate of spawner numbers in the interior Fraser watershed (Figure 5), as well as useful information on stock composition. Results indicated that spawner surveys may be missing significant numbers of coho, particularly in non-Thompson streams. Additional survey work is required to verify the distribution of coho in the upper Fraser watershed, determine abundance, and collect baseline genetic samples.

The authors updated their information on the population structure of interior Fraser coho, and present evidence that indicates that major drainage basins (e.g. North and South Thompson) may need to be considered as separate Conservation Units. They discuss reference points for various coho populations and present several calculated using data from North Thompson coho. The mean of two minimum reference points was 5.2 female spawners per kilometre of accessible habitat. The authors presume that a limit reference point for North Thompson coho would be greater than or equal to this value. Since coho escapements in the North Thompson watershed have been near but generally below this mean reference point the past four years, they conclude that the viability of these fish remains at risk. This, combined with the short-term forecast for Thompson coho of continued poor survivals, leads to their recommendation that a cautious approach to fisheries management needs to remain in place in order to allow these populations the opportunity to rebuild.

The major recommendations from this paper are:

1. More extensive baseline coverage of interior Fraser coho, especially in non-Thompson tributaries upstream of the Fraser-Thompson confluence are required to aid in the delineation of populations and Conservation Units, and provide more precise estimates of the distribution and numbers of interior Fraser coho in catches.
2. Rates of genetic exchange between generations and among populations need to be determined.
3. To enable more effective fisheries management, coho encounter and DNA based stock composition information should be used to develop a model of coho marine distribution and migratory timing.
4. Although benefits can be seen from the extreme fishery management measures taken in recent years, these measures should remain in place to permit populations the opportunity to rebuild.

Reviewers' Comments

Reviewer #1

This report is a substantial update building on previous reports of population-level escapement, harvest and productivity data for interior Fraser coho. It also represents the aggregation of much concerted effort to characterize the genetic sub-population structure and to utilize this information in management actions to restrict fishing mortalities and promote rebuilding of interior Fraser coho. Finally,

it includes a new and promising approach to aid in the development of limit reference points for salmon Conservation Units and in the evaluation of extinction risk when choosing a particular limit reference point (LRP). The reviewer recommended that the paper be accepted with some revision, the most significant of which are mentioned below.

One of the most positive contributions made by this report is in bringing together extensive and diverse sources of timely data for interior Fraser coho. This leads at the same time, however, to its' biggest shortcoming – short shrift in discussion and integration of the new data and approaches in significant sections of the report. For example, a huge amount of stock composition data, based on the analysis of DNA in tissue samples collected from many fisheries in different time periods and locations in three successive years, are detailed in Appendices 1 and 2 of the working paper. Beyond mentioning, however, in the section on 'Data Sources and Treatments' that the data are in the report, there is no further description or discussion of these data. A general summary mentioning any notable differences among sampling years, etc. would be helpful.

Another important topic that requires greater development and discussion concerns the authors' proposal of four potential LRPs and three TRPs (target reference points). This is the first attempt to determine these for interior coho and while the reviewer commended the authors for doing so when no DFO-recommended guidelines currently exist, their treatment in the text is too brief to inspire confidence. The LRPs also seem low and they would likely benefit from more detailed treatment. One of the LRPs in particular, is based on a promising new extension of Ricker stock-recruitment analysis (the incorporation of a non-zero spawner limit into the standard model below which extinction risk is thought to be substantial) but is given only minimal description and discussion in this report. This does not do justice to the potential merit of this new approach and the reviewer suggested that it be developed more fully within the report itself rather than treated as an Appendix.

Reviewer #2

This reviewer felt that it would have been very useful if the spawner and recruit data used in the analysis of S_{offset} had been described in more detail. An annotated table of estimates would be particularly useful. It is difficult to tell from which of the many data sources the estimates were taken, which were determined independently and which relied on data collected in other years, and other characteristics of the time series that may affect the estimation process.

Reviewer # 2 felt that the proposed limit reference point for the north Thompson may be too low based on the data presented and the uncertainties of the various estimates. The "Historical minimum escapement" reference point presented in Table 9 of the working paper is for 1997. In principle, this reference point should be the historical minimum escapement from which the stock has recovered

which is instead 1980. The stock has yet to recover from the 1997 historical minimum. In principle, there should be a low probability of the stock falling below the limit reference point. One way to do this is to "buffer" the limit reference point by incorporating its uncertainty. For example, the probability distribution of the S_{offset} estimate could be used as a basis for such a buffer. Similarly, the proposed reference point is the average of 4 "independent" estimates. It should be possible to calculate the distribution of this estimator and use this in determining the limit. It is clear from the autocorrelated residuals of the stock recruitment relationship that productivity in the recent period has been below average. It would be necessary to increase the limit reference point in such periods of low productivity. All of these considerations imply the use of a higher limit reference point.

There is potential for developing an integrated assessment/forecast tool for this assessment which would simultaneously estimate stock size, limit, and target reference points. It should be possible to estimate the joint probability of both status indicators and reference points to address one of the concerns mentioned above.

Subcommittee Discussion

The Subcommittee expressed reservation about the authors' recommendations regarding reference points for the reasons presented in the 'General Discussion' section of this report. The Subcommittee agreed however, that the authors' summary of alternative reference points for North and South Thompson coho was useful and should be presented because it provides a biological context for interpreting stock status.

The Subcommittee noted that the estimate for spawning density required to fully seed freshwater habitat (carrying capacity in the "freshwater model") was less than the maximum sustainable yield estimate from the proposed stock-recruitment model. The authors agreed to investigate this conceptual inconsistency.

Discussion included a concern raised by one reviewer that the assumed 10% handling mortality at the fishwheels was problematic given that strict measures had been imposed to limit fishing mortality to 2% in southern B.C. The authors explained that the assumed 10% mortality applied only to fish that were tagged, a small proportion of all fish handled during field operations. Overall mortality from the tagging program expressed as a percentage of the total run was estimated at about 0.2%.

The authors pointed out to the Subcommittee that Interior Fraser coho have been managed as a single unit since 1995. The authors presented a theoretical basis for identifying more than one conservation unit and the Subcommittee agreed that development of conservation units for Interior Fraser coho is

required.

The Subcommittee advised that Thompson coho abundance has stabilized following reductions in fishing mortality in 1998 to 2000. Escapements in 1999 and 2000 were generally larger than brood year escapements (Figure 6). Greater proportions of fish surviving to maturity are returning to spawn because of the significant reductions in fishing pressure. Although productivity improved for broods returning in 1999 and 2000 and abundance has stabilized, abundance remains near or below all biological reference points considered and continued restrictions on fishing mortality for interior Fraser coho in 2001 is required.

The status of non-Thompson interior Fraser stocks could not be assessed because of the lack of a reliable time series of abundance data.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions.

The Subcommittee recommended that current restrictions on fishing mortality for interior Fraser coho in 2001 be continued.

S2001-14: Review of the year 2000 return of Barkley Sound sockeye salmon and forecasts for 2001

K. Hyatt, W. Luedke, P. Rankin, J. Till and D. Lewis **Accepted subject to revisions**

Summary

Returns of Barkley Sound sockeye have been variable but well below the long term average return of 820,000 adults for the past 7 years. Although variable, recent year returns reflect a continuation of a pattern of predictable variations in ocean climate and survival conditions for juvenile sockeye salmon that have lead to repeated "crashes" (1978, 1985-86, 1989-90, 1994-95) usually followed within 1-3 years by recoveries (1979-81, 1987-88, 1991-93, 1996-98) of WCVI sockeye returns. The prolonged interval of sub-average returns between 1994 and 2000 is anticipated to end in 2001 as ocean climate signals suggest increased marine survival rates for Barkley Sound sockeye smolts migrating seaward during the 1998-2000 interval.

Over the past 12 years, four independent techniques have been tested for their utility in generating reliable pre-season forecasts of Barkley Sound sockeye returns for fisheries managers. The four techniques are known as the Salinity Survival Method (SSM), the Survival Stanza Method (SStM), the Sibling Age Class Method (SACM), and the Salmonid Enhancement Program Biostandard Method (SEPB). Updates on the performance of three of these techniques in the year 2000 are as follows:

(1) The SStM forecast exhibits the best overall performance with a Mean Absolute Percent Error (MAPE) value of approximately 31% over the most recent 13 years of forecasting. Further, SStM forecasts account for the majority of variations in returns if the extreme observation associated with the 1991 return year is omitted from the analysis (returns = 1.17 SStM forecasts – 66.35, $r^2 = 0.77$, $P<0.01$).

(2) If the year 2000 forecast is excluded, the SSM forecast exhibits the next best performance with a MAPE value of 35% over the most recent 12 years of forecasting. SSM forecasts also exhibited a statistically significant association with returns between 1988 and 1999. However, the SSM forecast was biased high by more than 400% relative to year 2000 returns such that its MAPE value increased to 68.7%. Consequently, the full set of SSM forecasts was reduced to a statistically insignificant relation with observed returns.

(3) SEPB forecasts have performed well over some return intervals but not others. During the 1988-1998 testing interval SEPB forecasts exhibited a substantially higher MAPE value (54%) than that displayed by both SSM and SStM forecasts (28-34%). The SEPB forecast, like the SSM forecast was biased high by a large margin (194%) relative to year 2000 returns although the predictive power of the SEPB forecasts still achieved statistical significance. Large magnitude deviations between SEPB forecasts and actual returns tend to occur in consecutive years which seriously erodes the confidence in their utility.

Forecasts provided by different models exhibit less divergence in predicted returns of Barkley Sound sockeye in 2001 than was the case in the year 2000. Midpoint forecast estimates range from a low of 813,000 (SStM model) to a high of 1,865,000 (SSM model) Barkley Sound sockeye (Table 1). Comparative performance of the various forecast options, along with DFO's recent pursuit of a more risk averse approach to management recommends initial adoption of the SStM forecast range of 738,000 (75% probability) to 1,091,000 (25% probability) sockeye as the preferred, pre-season forecast for the year 2000. However, supplementary information (from coho leading indicator observations) suggests that returns are likely to be closer to the upper than the lower end of this range.

Subcommittee Discussion

The Subcommittee discussed the performance of the 2000 forecasts from the three main models and the relative merits of the various forecasts for 2001. Concerns were raised about the poor performance of all the forecasts for the 2000 return, with all three forecasts substantially overestimating the actual return. Historically, the forecasts from the SStM and SSM models have typically been closer, but for both 2000 and 2001 the forecasts from these two models have been very divergent. Concerns were raised that all the forecasts for the

sockeye return in 2001 may also again be too high. The authors responded that the ocean climate conditions along the west coast of Vancouver Island were more normal in 1999 when the smolts went to sea, compared to 1998. Also, the difference between the SStM forecast and the SSM forecast is smaller for the 2001 return, compared to the difference in the 2000 forecasts, so the potential errors in the forecasts for the return in 2001 are likely more accurate. However, a very cautious approach should be taken in 2001 due to the unexpected large deviation that occurred between the 2000 forecast and the actual return in 2000.

Concerns were also raised about the possibility of a shift in the age structure of sockeye that return in 2001, which might also affect the accuracy of the forecasts for 2001. The authors responded that historically there has been a very strong relationship between the number of 4 year olds that return in one year, and the number of 5 year olds that return the following year. Age 4 and age 5 sockeye have always comprised the majority of the return for Barkley Sound sockeye, so a major change in the 2001 return of sockeye due to a shift in age at return between age 4 and age 5 fish is unlikely. However, the authors acknowledged that 3 year old (jack) sockeye can comprise up to about 10% of the annual return and the historical relationship between the return of age 3 and age 4 sockeye and is much more variable and uncertain.

The Subcommittee also questioned the general utility of the current forecasting methods given the poor performance in recent years, and discussed the merits of exploring alternate approaches. The Subcommittee discussed the merits of the new Coho Leading Indicator (CLI) forecasting method. Although adequate evaluation of this model has not yet been completed, the Subcommittee agreed with the authors that this method appears promising and that the authors should be encouraged to complete the development of this method. A full description and a retrospective analyses of the likely performance of the forecasts from this model using the historical range of data would be very useful and should be prepared as a separate working paper for consideration by the Subcommittee.

The Subcommittee noted that the annual forecasts for Barkley Sound sockeye are used only for pre-season planning. These forecasts are not used for any part of the in-season management of the fisheries. Given the effort required to develop the annual forecasts, and the poor performance of the forecasts in recent years, the Subcommittee recommended a review of the utility and necessity of continuing to produce annual forecasts for Barkley Sound sockeye.

Concerns were also raised about the actual utility of these forecasts for fisheries management, given that the current forecasts include all ages at return, but the surpluses available for harvest include only the age 4 and age 5 sockeye (the 3-year old jacks are not harvested). If the return in a given year includes a substantial number of jacks then the value of the forecast for the total return is less useful to fishery managers. Given these concerns and the concerns noted previously, the Subcommittee requested clarification on information required by

fisheries managers for forecasts of Barkley Sound sockeye.

The Subcommittee identified and requested that the authors address the apparent inconsistencies of data provided in various parts of the working paper and the equations for the CLI model, and clarify some of the wording and the abbreviations used (mainly in the Tables). The authors also agreed to identify which in-season indicators should be reviewed in their recommendation regarding a review of Barkley Sound sockeye return indicators.

Subcommittee Recommendations

The Subcommittee accepted the paper subject to revisions.

The Subcommittee accepted the forecast return for Barkley Sound sockeye in 2001 based on the SStM model. The forecast return of adults (age-4 and age-5) is 813,000 at the 50% probability level, and 738,000 at the 75% probability level.

The Subcommittee recommended that the key in-season indicators (sockeye abundance, age at maturity, run timing, etc.) be carefully monitored due to the large divergence of the forecasts from the alternate methods.

APPENDIX 1: PSARC SALMON SUBCOMMITTEE MEETING AGENDA, MAY 1-3, 2001

PSARC Salmon Subcommittee Meeting
May 1-3, 2001
Seminar Room, PBS, Nanaimo

Agenda

Tuesday, May 1, 1:00

Introductions and procedures
Meziadin Lake Sockeye Salmon (R.C. Bocking et al.)
Queen Charlotte Island Coho (B. Spilsted et al.)

Wednesday May 2, 08:30

New Jake Fraser Recovery Box (B. Hargreaves et al.)
Georgia Basin Coho stock status (K. Simpson et al.)
Interior Fraser River Coho salmon (J. Irvine et al.)
Early returning chinook salmon of the Fraser River Watershed (R. Bailey et al.)
Review of rapporteur reports

Thursday May 3, 09:00

Barkley Sound Sockeye Salmon (Hyatt et al.)
Review of rapporteur reports

APPENDIX 2: PSARC SALMON WORKING PAPERS FOR MAY 2001

S2001-08	Meziadin Lake biological escapement goal and options for increasing yield of sockeye salmon (*Oncorhynchus nerka*)	R.C. Bocking M.R. Link B. Baxter B. Nass L. Jantz
S2001-09	Assessment of coho stocks on the Queen Charlotte Islands/Haida Gwaii, 2001	B. Spilsted P. Fairweather R.C. Bocking
S2001-10	Mortality rates of coho salmon caught by commercial salmon gillnets and the effectiveness of revival tanks and reduced soak time for decreasing coho mortality rates	B. Hargreaves C. Tovey
S2001-11	Status in 2000 of coho stocks adjacent to the Strait of Georgia	K. Simpson D. Dobson R. Semple S. Lehmann S. Baillie I. Matthews
S2001-12	Summary of stock assessment information for selected early returning chinook salmon populations of the Fraser River watershed	R. E. Bailey J. R. Irvine J. R. Candy C. K. Parken S. L. Lemke M. Sullivan M. Wetklo
S2001-13	2001 assessment of stock status for coho salmon from the Interior Fraser River	J. R. Irvine C. K. Parken D. G. Chen J. Candy T. Ming Supernault W. Shaw R. E. Bailey
S2001-14	Review of the year 2000 return of Barkley Sound sockeye salmon and forecast for 2001	K. Hyatt W. Luedke P. Rankin J. Till D.Lewis

APPENDIX 3: PARTICIPANTS AT SALMON SUBCOMMITTEE MEETING, MAY 1-3, 2001

Subcommittee Chair: Allan Macdonald
PSARC Chair: Max Stocker

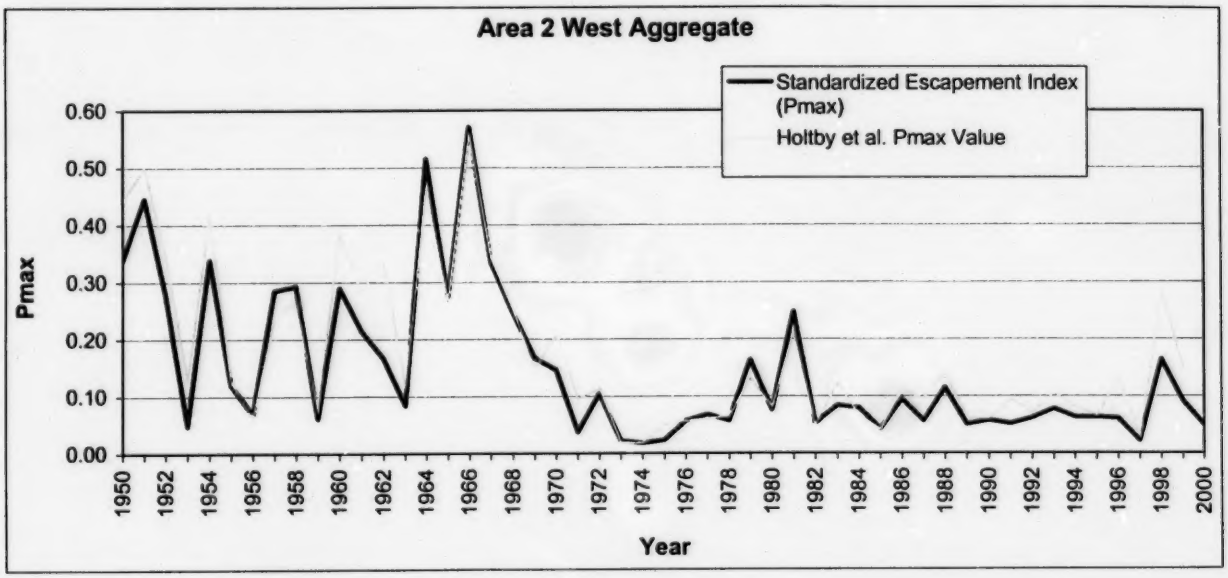
DFO Participants	Tues	Wed	Thurs
* Subcommittee Members			
Anderson, D.*		✓	
Bailey, D.*	✓	✓	✓
Bailey, R.	✓	✓	
Bailey, S.		✓	
Brown, G.	✓	✓	✓
Cass, A. *	✓	✓	✓
Cox-Rogers, S.*	✓	✓	
Curry, G.		✓	
Dobson, D.		✓	✓
Folkes, M.	✓		
Hargreaves, B.*		✓	✓
Holtby, B.*	✓	✓	✓
Hyatt, K.*	✓		
Irvine, J.*	✓	✓	✓
Jantz, L.*	✓	✓	
Lemke, S.	✓	✓	
Meerburg, D.*	✓	✓	✓
Parken, C.	✓	✓	
Perry, T.	✓		
Riddell, B.*	✓	✓	
Simpson, K.		✓	
Spilsted, B.	✓	✓	
Sullivan, M.*	✓	✓	✓
Winther, I.		✓	
Wood, C.*	✓		
Yockey, C.	✓	✓	
External Participants:			
Atkinson, M.	✓	✓	
Chow, S.	✓	✓	
Harling, W.	✓	✓	
Rombough, L.		✓	
Tautz, A.*	✓	✓	
Wilson, K.	✓	✓	✓
Observers:			
Blackbourn, D.	✓	✓	✓
Scarfo, K.		✓	

List of Reviewers

Anderson, D.	DFO, Stock Assessment Division
Bradford, M.	DFO, Marine Environment and Habitat Science Division
Brown, G.	DFO, Stock Assessment Division
Cass, A.	DFO, Stock Assessment Division
Cox-Rogers, S.	DFO, Stock Assessment Division
Folkes, M.	DFO, Stock Assessment Division
Hyatt, K.	DFO, Stock Assessment Division
Kreiberg, H.	DFO, Aquaculture Division
McNicol, R.	DFO, Stock Assessment Division
Rutherford, D.	DFO, Stock Assessment Division
Sinclair, A.	DFO, Stock Assessment Division

TABLES AND FIGURES

Figure 1. Comparison of Standardized Coho Escapement Index (Pmax) Values for Area 2 West Aggregate Streams and Annual Escapement Estimates (All Streams).



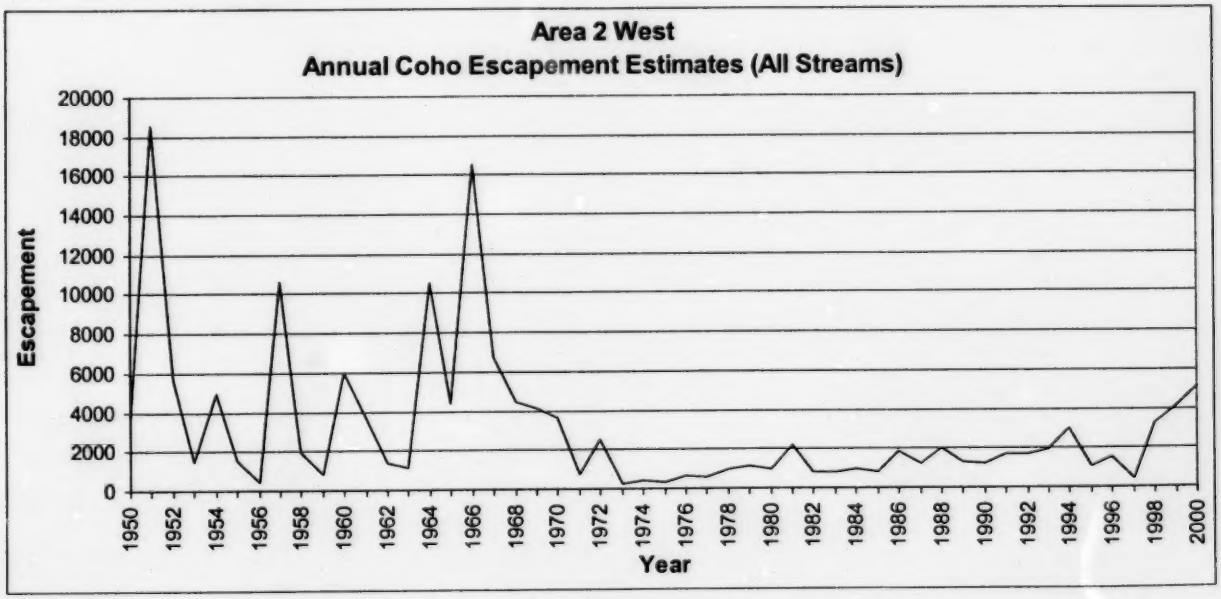
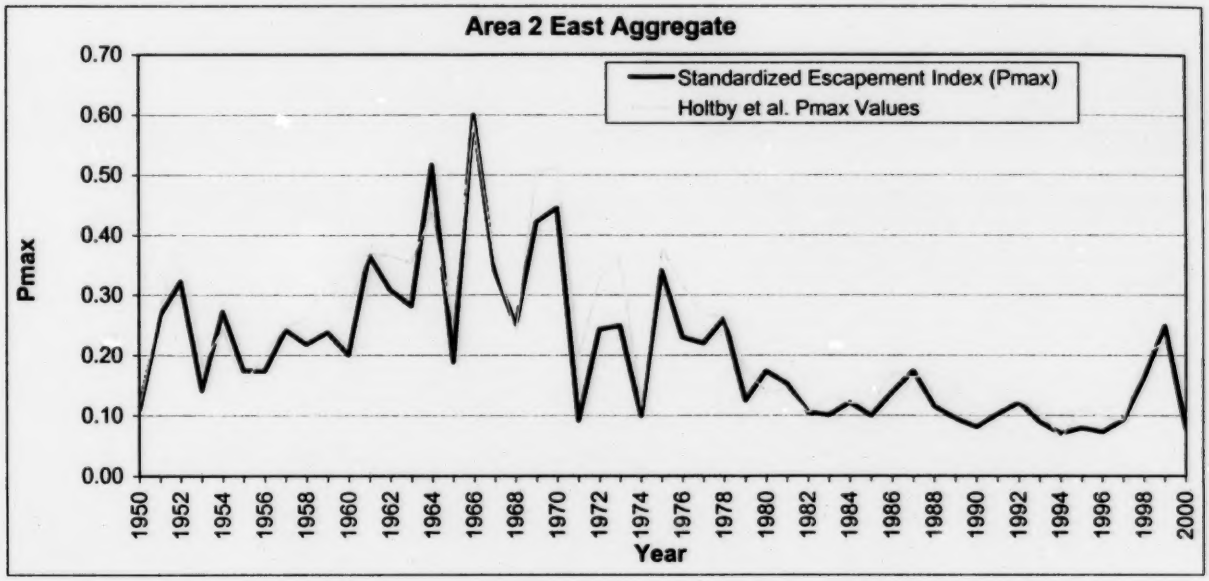


Figure 2. Comparison of Standardized Coho Escapement Index (Pmax) Values for Area 2 East Aggregate Streams and Annual Escapement Estimates (All Streams).



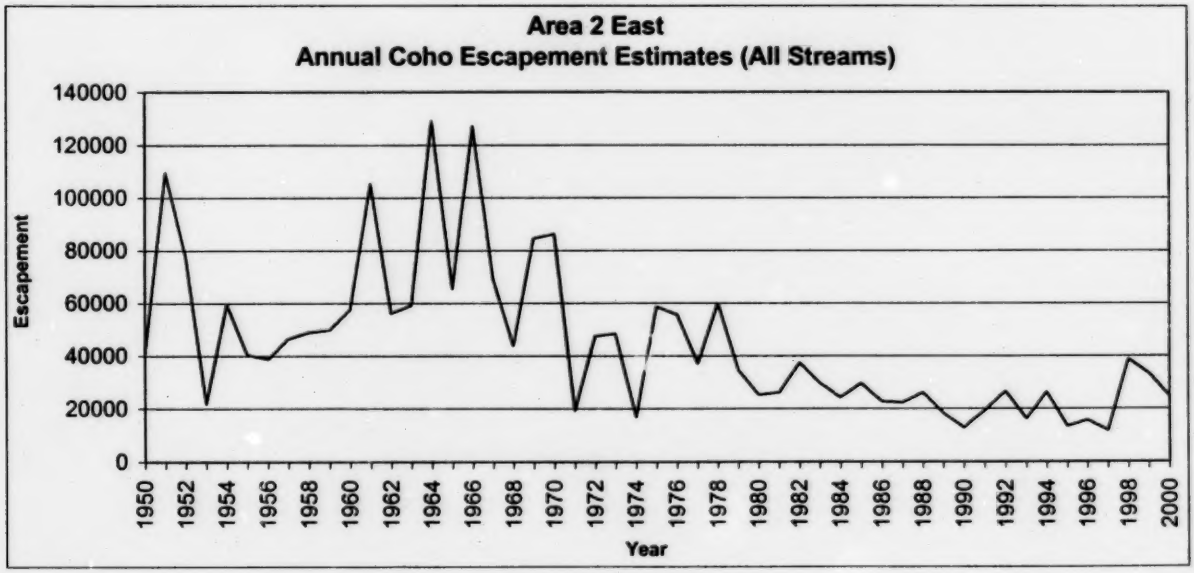


Figure 3: Coho Catch Mortality for Soak Groups between 20 and 65 +/- 2 Minutes for Alberni Inlet 1998 Experiment

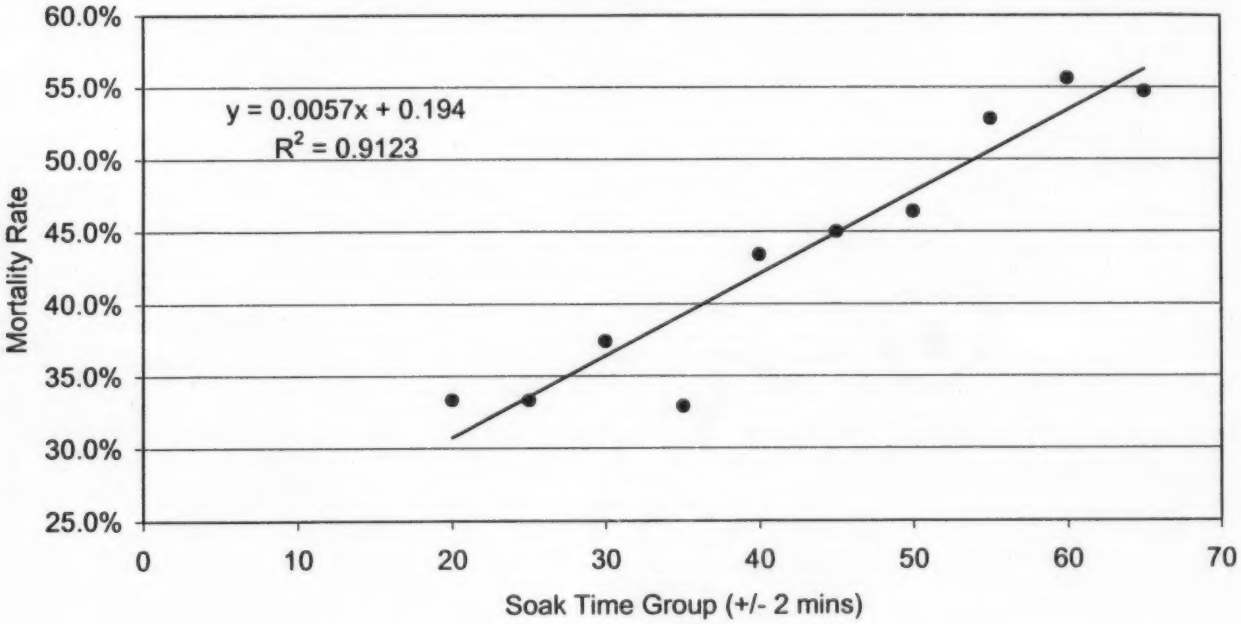


Figure 4: Percent of Coho in Condition 3 at capture that revived to Condition 1 at the time of release from the revival tanks in the Alberni Inlet 1998 experiment
10 Minute intervals for 30 min Soak Group (>60 min not included)

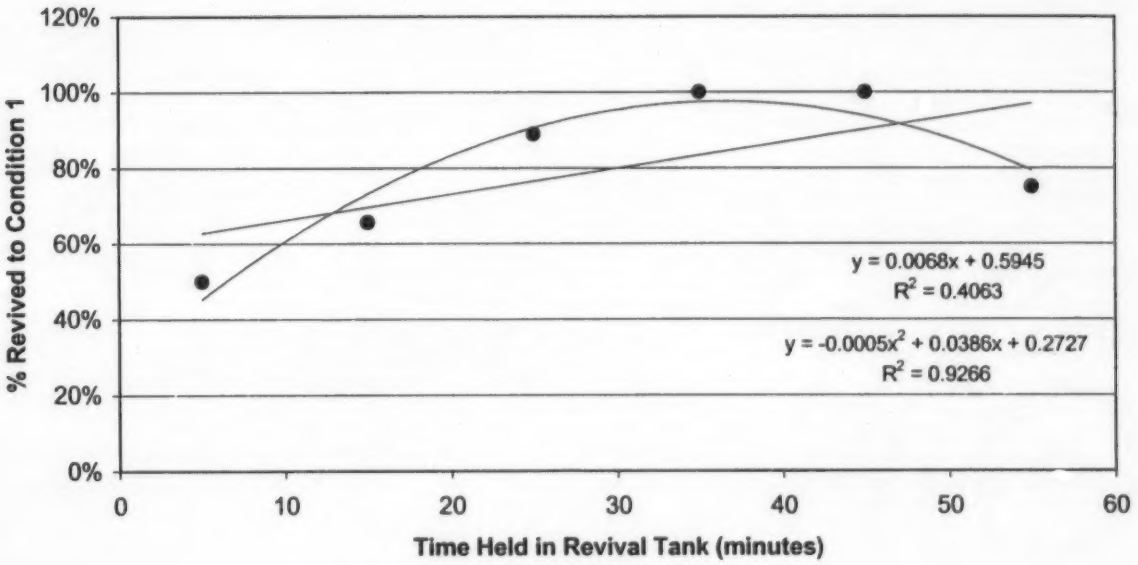


Figure 5. Known and suspected distribution of coho salmon within the interior Fraser River watershed. Major watersheds indicated are 1-Nahatlatch, 2-L. Thompson, 3-Nicola, 4-N. Thompson, 5-S. Thompson, 6-Seton, 7-Bridge, 8-Chilcotin, 9-Quesnel, 10-Westroad, 11-Nechako, 12-Stuart, 13-Bowron, and 14-Upper Fraser.

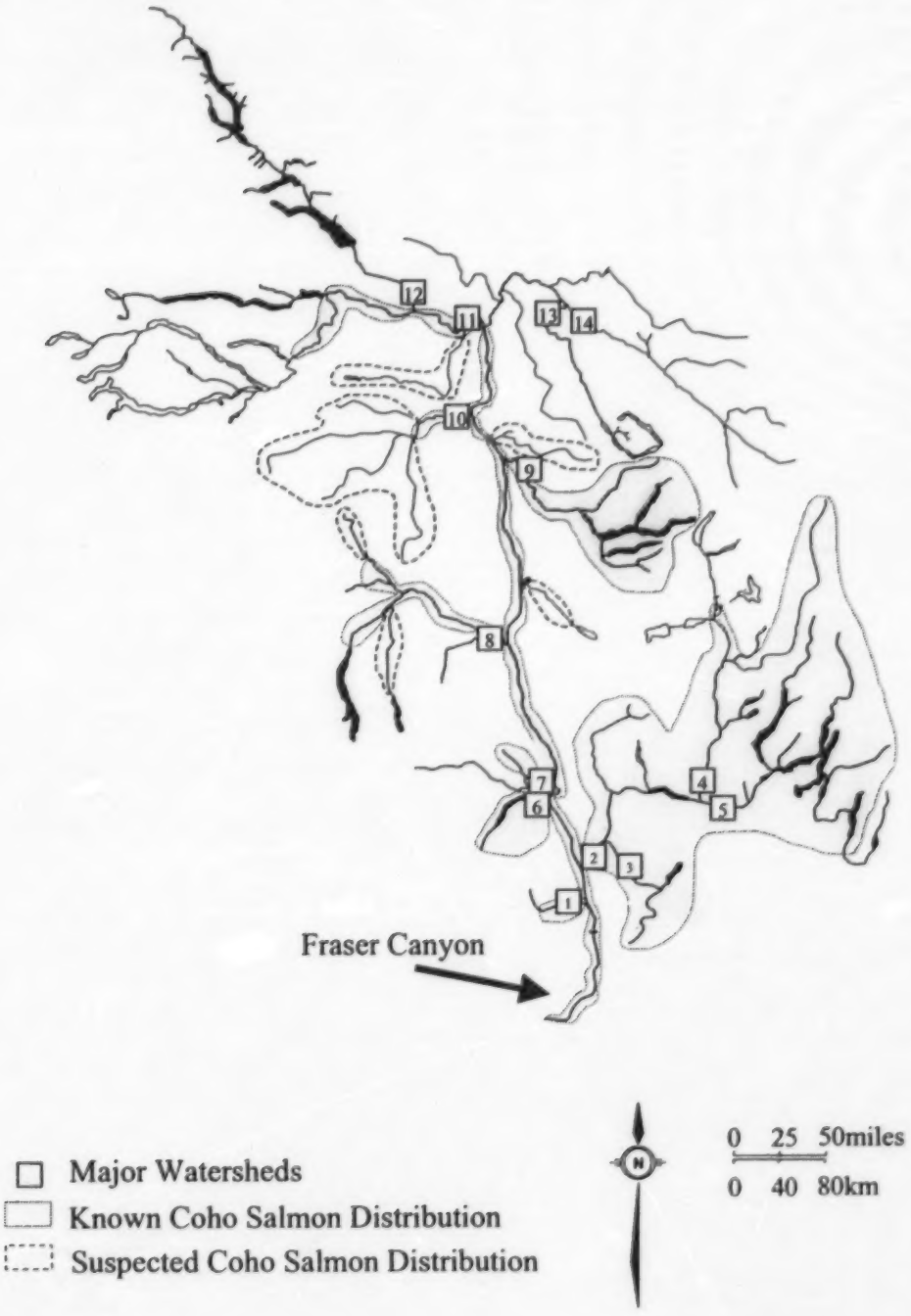


Figure 6. Aggregate coho escapement to 16 escapement indicator streams in the South Thompson watershed.

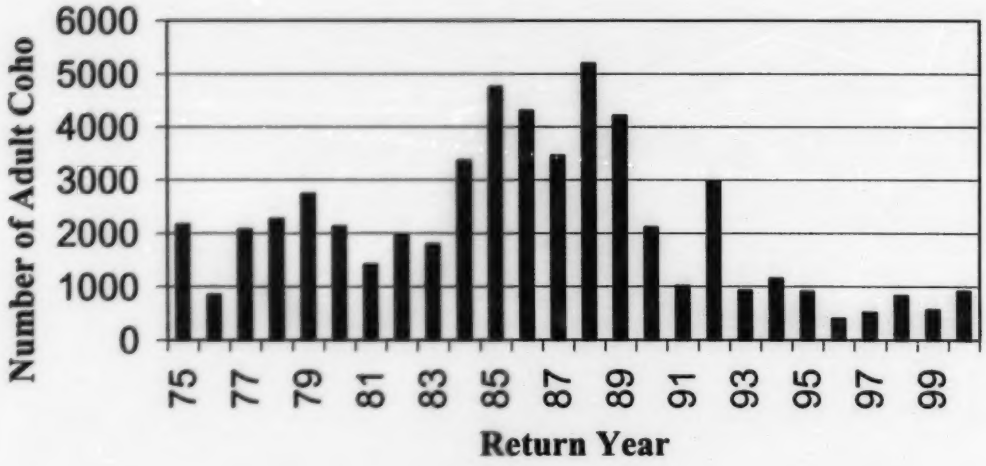


Table 1: Barkley Sound sockeye year 2001 return forecasts.

	Probability of Achieving Specified Run Sizes*			
Forecast	25%	50%	75%	90%
SStM	1,090,849	**813,338**	738,267	553,070
SEPB	1,268,486	**1,036,006**	292,775	NA<0
SSM	2,106,700	**1,865,327**	1,163,777	NA < 0

* probability that the actual run size will exceed the specified forecast.